UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/404,932	09/24/1999	Christian Friedl	MFL-001	8927

21323 7590 08/28/2003

TESTA, HURWITZ & THIBEAULT, LLP
HIGH STREET TOWER
125 HIGH STREET
BOSTON, MA 02110

EXAMINER	
THANGAVELU, KANDASAMY	
ART UNIT	**PAPER NUMBER**
2123	8

DATE MAILED: 08/28/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

7

Office Action Summary	Application No. 09/404,932	Applicant(s) FRIEDL ET AL.	
	Examiner Kandasamy Thangavelu	Art Unit 2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 24 September 1999 .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-25 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-25 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 24 September 1999 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 5,6 & 7 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Introduction

1. Claims 1-25 of the application have been examined.

Information Disclosure Statement

2. Acknowledgment is made of the information disclosure statements filed on September 20, 2000, February 15, 2001 and January 18, 2002 together with copies of the patents and papers. The patents and papers have been considered in reviewing the claims.

Drawings

3. The draft person has objected to the drawings; see a copy of Form PTO-948 for an explanation.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and

the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

5. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. Claims 1-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Yu et al. (YU)** (U.S. Patent 6,096,088) in view of **Kennedy (KE)** ("Flow Analysis of Injection Molds", Hanser Publishers, 1995).

6.1 **Yu** teaches Method for modeling three dimension objects and simulation of fluid flow. Specifically, as per Claim 1, **YU** teaches a method for modeling injection of a fluid into a mold defining a three dimensional cavity (Abs, L1-3; Fig. 15; CL1, L5-10); the method comprising the steps of:

(a) providing a three-dimensional solid computer model defining the cavity (CL1, L11-13; CL1, L58-61);

(b) discretizing a solution domain based on the solid model (CL2, L14-20; CL2, L22-24); and

(f) determining whether at least one of the respective filling phase solutions and packing phase solutions are acceptable (CL13, L27-33).

YU does not expressly teach (c) specifying boundary conditions. **KE** teaches specifying boundary conditions (Pg 5, Para 3; Pg 150, Eq 9.4-9.9; Pg 186, Eq 10.5-10.9), as boundary conditions are physical effects that cause the system to change; boundary conditions restrict the number of possible solutions and ensure a unique solution to the problem under consideration (Pg. 110, Para 7). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included specifying boundary conditions, as boundary conditions are physical effects that cause the system to change; boundary conditions would restrict the number of possible solutions and ensure a unique solution to the problem under consideration.

YU teaches filling phase and solving for filling phase process variables (CL1, L13-18; CL13, L12-27). **YU** does not expressly teach (d) solving for filling phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on the boundary conditions to provide respective filling solutions therefor for at least the portion of the solution domain. **KE** teaches (d) solving for filling phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on the boundary conditions to provide respective filling solutions therefor for at least the portion of the solution domain (Pg 59, Para 1; Pg 113, Para 6; Pg 149, Para 1 to Pg 152, Para 3), as conservation of mass means that the mass contained in a volume does not change (Pg 44, Sec 4.2); conservation of momentum requires that the time rate of change of the fluid momentum in a

volume is equal to the sum of external forces acting on the volume (Pg 46, Sec 4.3); conservation of energy means that the total energy of fluid in a volume is given by the sum of kinetic and internal energies (Pg 47, Sec 4.4); boundary conditions are physical effects that cause the system to change; boundary conditions restrict the number of possible solutions and ensure a unique solution to the problem under consideration (Pg. 110, Para 7). As per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included (d) solving for filling phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on the boundary conditions to provide respective filling solutions therefor for at least the portion of the solution domain, as conservation of mass would mean that the mass contained in a volume would not change; conservation of momentum would require that the time rate of change of the fluid momentum in a volume would be equal to the sum of external forces acting on the volume; conservation of energy would mean that the total energy of fluid in a volume would be given by the sum of kinetic and internal energies; boundary conditions are physical effects that would cause the system to change; boundary conditions would restrict the number of possible solutions and would ensure a unique solution to the problem under consideration. On the basis of calculated data and derived information, changes to the component geometry, position of the injection

locations, processing conditions and material of the molding might be evaluated for their efficacy in improving the quality or manufacturability of part.

YU teaches packing phase and solving for packing phase process variables (CL1, L13-18; CL13, L12-27). **YU** does not expressly teach (e) solving for packing phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on respective states of the process variables at termination of filling, to provide respective packing phase solutions therefor for at least the portion of the solution domain. **KE** teaches (e) solving for packing phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on respective states of the process variables at termination of filling, to provide respective packing phase solutions therefor for at least the portion of the solution domain (Pg 107, Sec 6.7; Pg 113, Para 6; Pg 185, Para 1 to pg 188, Para 2), as conservation of mass means that the mass contained in a volume does not change (Pg 44, Sec 4.2); conservation of momentum requires that the time rate of change of the fluid momentum in a volume is equal to the sum of external forces acting on the volume (Pg 46, Sec 4.3); conservation of energy means that the total energy of fluid in a volume is given by the sum of kinetic and internal energies (Pg 47, Sec 4.4); boundary conditions are physical effects that cause the system to change; boundary conditions restrict the number of possible solutions and ensure a unique solution to the problem under consideration (Pg. 110, Para 7). As per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have

been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included (e) solving for packing phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on respective states of the process variables at termination of filling, to provide respective packing phase solutions therefor for at least the portion of the solution domain, as conservation of mass would mean that the mass contained in a volume would not change; conservation of momentum would require that the time rate of change of the fluid momentum in a volume would be equal to the sum of external forces acting on the volume; conservation of energy would mean that the total energy of fluid in a volume would be given by the sum of kinetic and internal energies; boundary conditions are physical effects that would cause the system to change; boundary conditions would restrict the number of possible solutions and would ensure a unique solution to the problem under consideration. On the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding might be evaluated for their efficacy in improving the quality or manufacturability of part.

Dependent claims:

Per Claim 2: **YU** and **KE** teach the method of Claim 1. **YU** teaches that the filling phase process variables and packing phase process variables are selected from the group consisting of density, fluidity, mold cavity fill time, mold cavity packing time, pressure, shear rate, shear stress, temperature, velocity, viscosity, and volumetric shrinkage (CL13, L14-27).

Per Claim 3: **YU** and **KE** teach the method of Claim 1. **YU** teaches (g) modifying at least one of the discretized solution domain and the boundary conditions in the event at least one of the respective filling phase solutions and packing phase solutions is determined to be unacceptable (CL13, L27-41); and

(h) repeating steps (d) through (g), iteratively, until the respective filling phase solutions or packing phase solutions are determined to be acceptable (CL13, L27-38).

Per Claim 4: **YU** teaches computing a filling phase solution consisting of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity (CL13, L14-27). **YU** does not expressly teach displaying in graphics format a filling phase solution selected from the group consisting of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity. **KE** teaches displaying in graphics format a filling phase solution selected from the group consisting of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity (Pg 114, Para 1; Pg 149, Para 1 to Pg 152, Para 3), as analysis results in the tabular format are difficult to interpret and graphical displays can plot contours of the calculated variables over the model of the part for easy interpretation (Pg 114, Para 1). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included displaying in graphics format a filling phase solution selected from the group consisting of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity, as analysis results in the tabular format would be difficult to interpret and graphical displays could plot contours of the calculated variables over the model of the part for easy interpretation.

Per Claim 5: **YU** teaches computing a packing phase solution consisting of density, packing time, pressure, shear rate, temperature, velocity, viscosity, and volumetric shrinkage

(CL13, L14-27). **YU** does not expressly teach displaying in graphics format a packing phase solution selected from the group consisting of density, packing time, pressure, shear rate, temperature, velocity, viscosity, and volumetric shrinkage. **KE** teaches displaying in graphics format a packing phase solution selected from the group consisting of density, packing time, pressure, shear rate, temperature, velocity, viscosity, and volumetric shrinkage (Pg 114, Para 1; Pg 185, Para 1 to Pg 188, Para 2), as analysis results in the tabular format are difficult to interpret and graphical displays can plot contours of the calculated variables over the model of the part for easy interpretation (Pg 114, Para 1). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included displaying in graphics format a filling phase solution selected from the group consisting of fill time, pressure, shear rate, shear stress, temperature, velocity, and viscosity, as analysis results in the tabular format would be difficult to interpret and graphical displays could plot contours of the calculated variables over the model of the part for easy interpretation.

6.2 As per Claim 6, **YU** teaches a method for modeling injection of a fluid into a mold defining a three dimensional cavity (Abs, L1-3; Fig. 15; CL1, L5-10); the method comprising the steps of:

(a) providing a three-dimensional solid computer model defining the cavity (CL1, L11-13; CL1, L58-61);

(b) discretizing a solution domain based on the solid model (CL2, L14-20; CL2, L22-24); and

(e) determining whether the respective solutions are acceptable for injection of the fluid during filling of the mold cavity (CL13, L27-33).

YU does not expressly teach (c) specifying boundary conditions. **KE** teaches specifying boundary conditions (Pg 5, Para 3; Pg 150, Eq 9.4-9.9; Pg 186, Eq 10.5-10.9), as boundary conditions are physical effects that cause the system to change; boundary conditions restrict the number of possible solutions and ensure a unique solution to the problem under consideration (Pg. 110, Para 7). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included specifying boundary conditions, as boundary conditions are physical effects that cause the system to change; boundary conditions would restrict the number of possible solutions and ensure a unique solution to the problem under consideration.

YU teaches filling phase and solving for filling phase process variables (CL1, L13-18; CL13, L12-27). **YU** does not expressly teach (d) solving for filling phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on the boundary conditions to provide respective filling solutions therefor for at least the portion of the solution domain. **KE** teaches (d) solving for filling phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on the boundary conditions to provide respective filling solutions therefor for at least the portion of the solution domain (Pg 59, Para 1; Pg 113, Para 6; Pg 149, Para 1 to Pg 152, Para 3), as conservation of mass means that the mass contained in a volume does not change (Pg 44, Sec 4.2); conservation of momentum requires that the time rate of change of the fluid momentum in a

volume is equal to the sum of external forces acting on the volume (Pg 46, Sec 4.3); conservation of energy means that the total energy of fluid in a volume is given by the sum of kinetic and internal energies (Pg 47, Sec 4.4); boundary conditions are physical effects that cause the system to change; boundary conditions restrict the number of possible solutions and ensure a unique solution to the problem under consideration (Pg. 110, Para 7). As per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included (d) solving for filling phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on the boundary conditions to provide respective filling solutions therefor for at least the portion of the solution domain, as conservation of mass would mean that the mass contained in a volume would not change; conservation of momentum would require that the time rate of change of the fluid momentum in a volume would be equal to the sum of external forces acting on the volume; conservation of energy would mean that the total energy of fluid in a volume would be given by the sum of kinetic and internal energies; boundary conditions are physical effects that would cause the system to change; boundary conditions would restrict the number of possible solutions and would ensure a unique solution to the problem under consideration. On the basis of calculated data and derived information, changes to the component geometry, position of the injection

locations, processing conditions and material of the molding might be evaluated for their efficacy in improving the quality or manufacturability of part.

Dependent claims:

Per Claim 7: **YU** and **KE** teach the method of Claim 6. **YU** teaches that the discretizing step (b) comprises the substep of generating a finite element mesh based on the solid model by subdividing the model into a plurality of connected elements defined by a plurality of nodes (CL2, L14-20; CL2, L22-24).

Per Claim 8: **YU** does not expressly teach that the boundary conditions are selected from the group consisting of fluid composition, fluid injection location, fluid injection temperature, fluid injection pressure, fluid injection volumetric flow rate, mold temperature, cavity dimensions, cavity configuration, and mold parting plane, and variations thereof. **KE** teaches that the boundary conditions are selected from the group consisting of fluid composition, fluid injection location, fluid injection temperature, fluid injection pressure, fluid injection volumetric flow rate, mold temperature, cavity dimensions, cavity configuration, and mold parting plane, and variations thereof (Pg 5, Para 3; Pg 150, Eq 9.4-9.9; Pg 186, Eq 10.5-10.9), as boundary conditions are physical effects that cause the system to change; boundary conditions restrict the number of possible solutions and ensure a unique solution to the problem under consideration (Pg. 110, Para 7). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included the boundary conditions selected from the group consisting of fluid composition, fluid injection

location, fluid injection temperature, fluid injection pressure, fluid injection volumetric flow rate, mold temperature, cavity dimensions, cavity configuration, and mold parting plane, and variations thereof, as boundary conditions are physical effects that cause the system to change; boundary conditions would restrict the number of possible solutions and ensure a unique solution to the problem under consideration.

Per Claim 9: **YU** does not expressly teach that the solving step (d) utilizing the conservation of mass and conservation of momentum equations comprises the substeps of:

(i) solving for fluidity for at least some of the portion of the solution domain;

(ii) solving for pressure for at least some of the portion of the solution domain; and

(iii) calculating velocity for at least some of the portion of the solution domain.

KE teaches that the solving step (d) utilizing the conservation of mass and conservation of momentum equations (Pg 149, Para 1 to Pg 152, Para 3) comprises the substeps of:

(i) solving for fluidity for at least some of the portion of the solution domain;

(ii) solving for pressure for at least some of the portion of the solution domain; and

(iii) calculating velocity for at least some of the portion of the solution domain (Pg 151, Para 1 to Pg 152, Para 3), because as per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the

method of **KE** that included that the solving step (d) utilizing the conservation of mass and conservation of momentum equations comprising the substeps of:

(i) solving for fluidity for at least some of the portion of the solution domain;

(ii) solving for pressure for at least some of the portion of the solution domain; and

(iii) calculating velocity for at least some of the portion of the solution domain,

because on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding might be evaluated for their efficacy in improving the quality or manufacturability of part.

Per Claims10-15: **YU** does not expressly teach the solving step (d) utilizing the conservation of energy equation comprises the substep of calculating viscosity for at least some of the portion of the solution domain; the viscosity calculating substep is based on temperature; at least one of velocity and viscosity is calculated iteratively, until pressure converges; the substep of determining free surface evolution of the fluid in the cavity based on velocity; the substep of calculating temperature based on at least one of a convective heat transfer contribution, a conductive heat transfer contribution, and a viscous dissipation contribution; free surface evolution is determined iteratively, until the cavity is filled. **KE** teaches that the solving step (d) utilizing the conservation of energy equation comprises the substep of calculating viscosity for at least some of the portion of the solution domain; the viscosity calculating substep is based on temperature; at least one of velocity and viscosity is calculated iteratively, until pressure converges; the substep of determining free surface evolution of the fluid in the cavity based on velocity; the substep of calculating temperature based on at least one of a convective

heat transfer contribution, a conductive heat transfer contribution, and a viscous dissipation contribution; free surface evolution is determined iteratively, until the cavity is filled (Pg 151, Para 1 to Pg 152, Para 3), because as per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33).

It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included the solving step (d) utilizing the conservation of energy equation comprising the substep of calculating viscosity for at least some of the portion of the solution domain; the viscosity calculating substep being based on temperature; at least one of velocity and viscosity being calculated iteratively, until pressure converges; the substep of determining free surface evolution of the fluid in the cavity based on velocity; the substep of calculating temperature based on at least one of a convective heat transfer contribution, a conductive heat transfer contribution, and a viscous dissipation contribution; free surface evolution being determined iteratively, until the cavity is filled, because as per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part.

Per Claim 16: **YU** teaches packing phase and solving for packing phase process variables (CL1, L13-18; CL13, L12-27). **YU** does not expressly teach (f) solving for packing phase

process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on respective states of the process variables at termination of filling, to provide respective packing phase solutions therefor for at least the portion of the solution domain. **KE** teaches (e) solving for packing phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on respective states of the process variables at termination of filling, to provide respective packing phase solutions therefor for at least the portion of the solution domain (Pg 107, Sec 6.7; Pg 113, Para 6; Pg 185, Para 1 to pg 188, Para 2), as conservation of mass means that the mass contained in a volume does not change (Pg 44, Sec 4.2); conservation of momentum requires that the time rate of change of the fluid momentum in a volume is equal to the sum of external forces acting on the volume (Pg 46, Sec 4.3); conservation of energy means that the total energy of fluid in a volume is given by the sum of kinetic and internal energies (Pg 47, Sec 4.4); boundary conditions are physical effects that cause the system to change; boundary conditions restrict the number of possible solutions and ensure a unique solution to the problem under consideration (Pg. 110, Para 7). As per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included (e) solving for packing phase process variables using conservation of mass, conservation of momentum, and conservation of energy equations for at least a portion of the solution domain based on respective states of the

process variables at termination of filling, to provide respective packing phase solutions therefor for at least the portion of the solution domain, as conservation of mass would mean that the mass contained in a volume would not change; conservation of momentum would require that the time rate of change of the fluid momentum in a volume would be equal to the sum of external forces acting on the volume; conservation of energy would mean that the total energy of fluid in a volume would be given by the sum of kinetic and internal energies; boundary conditions are physical effects that would cause the system to change; boundary conditions would restrict the number of possible solutions and would ensure a unique solution to the problem under consideration. On the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding might be evaluated for their efficacy in improving the quality or manufacturability of part.

(g) determining whether the respective packing phase solutions are acceptable for injection of the fluid during filling of the mold cavity (CL13, L27-33).

Per Claim 17: **YU** does not expressly teach that the solving step (f) utilizing the conservation of mass and conservation of momentum equations comprises the substeps of:

(i) solving for fluidity for at least some of the portion of the solution domain;

(ii) solving for pressure for at least some of the portion of the solution domain; and

(iii) calculating velocity for at least some of the portion of the solution domain.

KE teaches that the solving step (f) utilizing the conservation of mass and conservation of momentum equations (Pg 185, Para 1 to Pg 186, Eq 4) comprises the substeps of:

(i) solving for fluidity for at least some of the portion of the solution domain;

(ii) solving for pressure for at least some of the portion of the solution domain; and

(iii) calculating velocity for at least some of the portion of the solution domain (Pg 185, Para 1 to Pg 188, Para 2), because as per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included that the solving step (f) utilizing the conservation of mass and conservation of momentum equations comprising the substeps of:

(i) solving for fluidity for at least some of the portion of the solution domain;

(ii) solving for pressure for at least some of the portion of the solution domain; and

(iii) calculating velocity for at least some of the portion of the solution domain, because on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding might be evaluated for their efficacy in improving the quality or manufacturability of part.

Per Claims18-21: **YU** does not expressly teach the solving step (f) utilizing the conservation of energy equation comprises the substep of calculating viscosity for at least some of the portion of the solution domain; the viscosity calculating substep is based on temperature; at least one of velocity and viscosity is calculated iteratively, until pressure converges; the substep of calculating temperature based on at least one of a convective heat transfer

contribution, a conductive heat transfer contribution, and a viscous dissipation contribution. **KE** teaches that the solving step (f) utilizing the conservation of energy equation comprises the substep of calculating viscosity for at least some of the portion of the solution domain; the viscosity calculating substep is based on temperature; at least one of velocity and viscosity is calculated iteratively, until pressure converges; the substep of calculating temperature based on at least one of a convective heat transfer contribution, a conductive heat transfer contribution, and a viscous dissipation contribution (Pg 185, Para 1 to Pg 188, Para 2), because as per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33).

It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** with the method of **KE** that included the solving step (f) utilizing the conservation of energy equation comprising the substep of calculating viscosity for at least some of the portion of the solution domain; the viscosity calculating substep being based on temperature; at least one of velocity and viscosity being calculated iteratively, until pressure converges; the substep of calculating temperature based on at least one of a convective heat transfer contribution, a conductive heat transfer contribution, and a viscous dissipation contribution, because on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part.

7. Claims 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Yu et al. (YU)** (U.S. Patent 6,096,088) in view of **Kennedy (KE)** ("Flow Analysis of Injection Molds", Hanser Publishers, 1995), and further in view of **Haverty (HA)** (U.S. Patent 5,989,473).

7.1 As per Claim 22, **YU** and **KE** teach the method of Claim 21. **YU** and **KE** do not expressly teach (h) calculating mass properties of a component produced in accordance with the boundary conditions. Per claim 23, **YU** and **KE** do not expressly teach the mass properties are selected from the group consisting of component density, volumetric shrinkage, component mass, and component volume. **HA** teaches calculating mass properties of a component produced in accordance with the boundary conditions; and the mass properties are selected from the group consisting of component density, volumetric shrinkage, component mass, and component volume (CL 7, L13-43), because as per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** and **KE** with the method of **HA** that included calculating mass properties of a component produced in accordance with the boundary conditions; and the mass properties would be selected from the group consisting of component density, volumetric shrinkage, component mass, and component volume, because on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of

the molding may be evaluated for their efficacy in improving the quality or manufacturability of part.

7.2 Per Claim 24: **Y, KE** and **HA** teach the method of Claim 22. **YU** and **HA** do not expressly teach that at least one of velocity, viscosity, and mass properties is calculated iteratively, until a predetermined pressure profile is completed. **KE** teaches that at least one of velocity, viscosity, and mass properties is calculated iteratively, until a predetermined pressure profile is completed (Pg 188, Para 2), because as per **YU**, on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part (CL13, L27-33). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** and **HA** with the method of **KE** that included at least one of velocity, viscosity, and mass properties being calculated iteratively, until a predetermined pressure profile is completed, as on the basis of calculated data and derived information, changes to the component geometry, position of the injection locations, processing conditions and material of the molding may be evaluated for their efficacy in improving the quality or manufacturability of part.

8. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Yu et al. (YU)** (U.S. Patent 6,096,088) in view of **Kennedy (KE)** ("Flow Analysis of Injection Molds", Hanser Publishers, 1995), and further in view of **Talwer et al. (TA)** ("Three dimensional simulation of polymer injection molding: verification", July 1998).

8.1 As per Claim 25, **YU** and **KE** teach the method of Claim 7. **YU** and **KE** do not expressly teach that the mesh generating substep comprises generating an anisotropic mesh in thick and thin zones such that mesh refinement provides increased resolution in a thickness direction without increasing substantially mesh refinement in a longitudinal direction. **TA** teaches that the mesh generating substep comprises generating an anisotropic mesh in thick and thin zones such that mesh refinement provides increased resolution in a thickness direction without increasing substantially mesh refinement in a longitudinal direction (Pg 53, CL1, Para 4 to CL2, Para 2), as the simulation process is made more effective in usage of resources by the employment of an anisotropic mesh that refines the mesh in the transverse direction to the flow (Pg 57, CL1, Para 2). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **YU** and **KE** with the method of **TA** that included the mesh generating substep comprising generating an anisotropic mesh in thick and thin zones such that mesh refinement provides increased resolution in a thickness direction without increasing substantially mesh refinement in a longitudinal direction, the simulation process would be made more effective in usage of resources by the employment of an anisotropic mesh that refines the mesh in the transverse direction to the flow.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to the Applicants' disclosure.

The following patents and papers are cited to further show the state of the art at the time of Applicants' invention with respect to three-dimensional simulation of injection molding.

1. Mori et al., "Simplified three dimensional simulation of non-isothermal filling in metal injection moulding by finite element method", Engineering computations, 1996.
2. Ding et al., "Finite element simulation of an injection moulding process", International journal of numerical methods for heat and fluid flow, 1997.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 703-305-0043. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska, can be reached on (703) 305-9704. The fax phone number for the organization where this application or proceeding is assigned is 703-746-7329.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-9600.

K. Thangavelu
Art Unit 2123
August 21, 2003

SAMUEL BRODA, ESQ.
PRIMARY EXAMINER